PROTOZOAN PARASITES OF THE ORTHOPTERA, WITH SPECIAL REFERENCE TO THOSE OF OHIO

II. DESCRIPTION† OF THE PROTOZOAN PARASITES RECOGNIZED IN THIS STUDY.‡

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MASTIGOPHORA

Leptomonas sp. (Plate I, Figs. 1 and 2.)

Hosts: *Parcoblatta virginica* (Brunner); *P. lata* (Brunner); *P. pen(n)sylvanica* (DeGeer).

Habitat: Hind-intestine.

Distribution: Champaign, Fairfield, Franklin, Hocking, Logan, Madison, and Washington Counties, Ohio.

Description: The organism is asymmetrically pyriform, 7.5 to 9μ in length by 3 to 4.5μ in width. The nucleus is granule-like. There is a single flagellum, 12 to 15μ in length and the blepharoplast is indistinguishable from the base of the flagellum. Leishmania-like organisms are present which are ovoid in shape and approximately 5 by 4μ in size, and possess two minute granule-like bodies (apparently nucleus and blepharoplast) and a short filament.

Affinities: By description (there is no illustration) this organism resembles *Leptomonas blaberae* Tejera, 1926, differing as to host (*Blabera* sp., Venezuela), length of flagellum (15 to 25μ), and slightly as to size (6.8 to 8 by 2.5 to 6μ).

Comment: It is inadvisable, because of insufficient characterization, to name this organism at the present.

SPOROZOA

Leidyana gryllorum (Cuénot, 1897) Watson, 1916. (Plate I, Fig. 3.)

References: Cuénot, 1897a, 54; Labbé, 1899, 10; Cuénot, 1901, 594; Watson, 1916a, 120; Bhatia and Setna, 1924, 288.

Synonymy: *Clepsidrina gryllorum* Cuénot, 1897a, 54; *Gregarina macrocephala* Labbé, 1899, 10; *G. gryllorum* Cuénot, 1901, 594; *Leidyana gryllorum* Watson, 1916a, 120.

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†All descriptions are made from types and paratypes on slide mounts in the author's collection.

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Hosts: *Gryllus assimilis* Fabricius; **G. domesticus* (Linnaeus); **G*, spp.; **Nemobius sylvestris* (Bosc d'Antic); *N. fasciatus fasciatus* (DeGeer).

Habitat: *Alimentary canal; *gizzard; enteric ceca; **mid-intestine.

Distribution: *Ardennes, Nancy, Joinville, and Roscoff, France; *Lahore, India; Franklin and Washington Counties, Ohio.

Description: The protomerite of this organism is a sphere, flattened posteriorly; the deutomerite is cylindric to tapering, terminating in a blunt point. There is a marked constriction at the septum. The epicyte and sarcocyte, collectively, are extremely thin over the entire surface. The endoplasm of the protomerite is moderately opaque and is white in reflected light; that of the deutomerite is somewhat more opaque in transmitted light. The nucleus is spherical and contains no karyosomes.

The measurements of the organism are as follows: Length and width of protomerite, 45 to 59μ by 65 to 71μ, averaging 52 by 68μ; of the deutomerite, 150 to 230μ by 78 to 97μ, averaging 190 by 87.5μ. Total length of the organism is 195 to 289μ, averaging 242μ. The nucleus is 32 to 39μ in diameter, averaging 35.5μ. (For all of the Gregarinida, measurements were taken of the representative specimens.)

Proportions are as follows: Length of protomerite to total length varies from 1 : 4.3 to 1 : 4.9, averaging 1 : 4.6; width of protomerite to width of deutomerite varies from 1 : 1.2 to 1 : 1.4, averaging 1 : 1.3.

No movement was observed, the organism usually being attached to debris posteriorly.

Two cephalonts (with globular epimerites) were observed. No other stages were recognized.

Comment: Approximately five stages intermediate between *Leidyana gryllorum* (Cuénot) and *L. erratica* (Crawley) were observed, indicating that these species might be extreme types of the same species. This corroborates the observations of Bhatia and Setna (1924, 288), who doubted that these Leidyanas were distinct species. A more complete statement will be withheld until further work has been done in this direction.

Leidyana erratica (Crawley, 1907) Watson, 1915. (Plate I, Figs. 4, 5, 6.)

References: Crawley, 1903a, 45; Crawley, 1903b, 639, 641; Crawley, 1907, 221; Ellis, 1913c, 286; Watson, 1915, 35; Watson, 1916a, 118; Kamm, 1922a, 133; Bhatia and Setna, 1924, 288.

Synonymy: *Gregarina achetaeabbreviatae* Crawley, 1903a, 45; *Stephanophora erratica* Crawley, 1907, 221; *Leidyana solitaria* Watson, 1915, 35; *L. erratica* Watson, 1916a, 118.

Hosts: ***Gryllus assimilis* Fabricius; *G. spp.; *Nemobius fasciatus fasciatus* (DeGeer); *N. fasciatus socius* Scudder; *Anaxipha exigua* (Say); *Hapithus agitator agitator* Uhler.

Habitat: *Alimentary canal; *gizzard; **enteric ceca; **mid-intestine.

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*Of other investigators only.

**Of the author as well as of other investigators

Unstarred information is of the author only.

Distribution: *Lahore, India; *Urbana, Illinois; *Cold Spring Harbor and Oyster Bay, New York; Champaign, Franklin and Washington Counties, Ohio.

Description: The protomerite of this organism is diamond-shaped; the deutomerite is cylindric and broadly rounded posteriorly, or tapering, terminating in a point, which varies from blunt to sharp. There is little or no constriction at the septum. The epicyte and sarcocyte, collectively, are extremely thin over the entire surface. The endoplasm of the protomerite is moderately opaque, and is white to yellowish in reflected light; that of the deutomerite is somewhat more opaque. The nucleus is spherical and contains no karyosomes.

The measurements are as follows: Length and width of protomerite, 22 to 91μ by 32 to 82μ, averaging 49.5 by 57μ; of the deutomerite, 195 to 435μ by 50 to 130μ, averaging 303 by 97μ. Total length of the organism, 217 to 526μ, averaging 352.5μ. Diameter of the nucleus, 15 to 58μ, averaging 35μ.

The proportions are as follows: Length of protomerite to total length varies from 1 : 5.8 to 1 : 9.6, averaging 1 : 7.3; width of protomerite to width of deutomerite varies from 1 : 1.2 to 1 : 2.2, averaging 1 : 1.7.

No movement was observed, the organism being almost invariably attached posteriorly to debris.

No other stages in the life cycle of the organism were recognized.

Comment: See comment for *Leidyana gryllorum.*

Gregarina ohioensis n. sp. (Plate I, Fig. 7.)

Hosts: *Parcoblatta virginica* (Brunner).

Habitat: Mid-intestine.

Distribution: Franklin County, Ohio.

Description: The primite protomerite of this organism is dome-like, and the deutomerite, an elongate cylinder. The satellite protomerite is flattened, and the deutomerite, elongate, tapering posteriorly to a point. There is no constriction at the septum of the primite, little at that of the satellite. The epicyte and sarcocyte of the association, collectively, are 19μ and less in thickness in the protomerites and 10μ, becoming much thinner posteriorly, in the deutomerites. The endoplasm of the association is moderately opaque, and is white in reflected light. The nucleus in both primite and satellite is a sphere, somewhat compressed.

The measurements are as follows: Length and width of primite protomerite, 123 by 247μ; of primite deutomerite, 910 by 292μ; of satellite protomerite, 110 by 286μ; of satellite deutomerite, 1072 by 292μ. Total length of primite, 1033μ; of satellite, 1182μ. Total length of association, 2215μ. Diameter of nuclei of primite and satellite, 65μ.

The proportions are as follows: Length of primite protomerite to total length, 1 : 8.4; of satellite, 1 : 10.7. Width of primite protomerite to width of deutomerite, 1 : 1.2; of satellite, 1 : 1.0.

No movement was observed.

*Of other investigators only.

No other stages were recognized.

Affinities: This organism resembles a variety of *Gregarina blattarum* Siebold, 1839, perhaps a distinct species, described by M. E. Watson (1916b), differing from it as follows: The primite protomerite of *G. ohioensis* n. sp. is dome-like and there is no constriction of the primite; the primite protomerite of Watson's variety of *G. blattarum* S. is bluntly pointed and there is a perceptible constriction of the primite.

The organism also resembles *Gregarina illinensis* Watson, 1915, differing from it as follows: The posterior end of the satellite is pointed in *G. ohioensis* n. sp. and rounded in *G. illinensis* W. There is no primite constriction in *G. ohioensis*, a perceptible one in *G. illinensis*. Other lesser differences may be noted.

Gregarina thomasi§ n. sp. (Plate I, Fig. 8.)

Hosts: *Parcoblatta pensylvanica* (DeGeer).

Habitat: Enteric ceca; mid-intestine.

Distribution: Fairfield County, Ohio.

Description: The primite protomerite of the organism is an elongate, blunt cone, irregularly shaped, and the deutomerite is elongate and irregular, slightly tapering posteriorly. The satellite protomerite is flattened, and the deutomerite is elongate and irregular, tapering to a blunt point. There is no constriction at the septa. The epicyte and sarcocyte of the association are 15μ and less in thickness in the protomerites, and are extremely thin in the deutomerites. The endoplasm of the association is translucent, and is white in reflected light. The nuclei are spherical and contain no karyosomes.

The measurements are as follows: Length and width of primite protomerite, 162 to 195μ by 182 to 195μ, averaging 170 by 187μ; of primite deutomerite, 710 to 910μ by 215 to 260μ, averaging 811 by 237μ; of satellite protomerite, 71 to 97μ by 195 to 218μ, averaging 79 by 207μ; of satellite deutomerite, 747 to 845μ by 227 to 295μ, averaging 792 by 268μ. Total length of primite, 872 to 1105μ, averaging 981μ; of satellite, 818 to 1592μ, averaging 871μ. Total length of association 1690 to 2697μ, averaging 1852μ. Diameter of nuclei of primite and satellite, 65μ each.

The proportions are as follows: Length of primite protomerite to total length varies from 1 : 4.6 to 1 : 6.6, averaging 1 : 5.65; of satellite, 1 : 10 to 1 : 12.7, averaging 1 : 11.35. Width of primite protomerite to width of deutomerite varies from 1 : 1.1 to 1 : 1.4, averaging 1 : 1.25; of satellite, 1 : 1.2 to 1 : 1.4, averaging 1 : 1.3.

The movement is slow, with twisting about debris in the path of the organism.

No other stages were recognized.

Affinities: This organism resembles *G. ohioensis* n. sp., differing from it as follows: The primite protomerite of *G. thomasi* n. sp. is an elongate, irregular, blunt cone; that of *G. ohioensis* n. sp. is dome-like. The primite deutomerite of *G. thomasi* n. sp. is irregular in shape and tapers slightly posteriorly; that of *G. ohioensis* n. sp. is regularly

§In honor of Edward S. Thomas, Curator of Natural History, Ohio Museum.

cylindrical. There is no constriction of the satellite in *G. thomasi* n. sp. while that in *G. ohioensis* is perceptible.

The organism differs from *G. blattarum* Siebold, Watson variety, in shape of primite protomerite, which is an elongate, irregular, blunt cone in *G. thomasi*, and is a papillate cone of moderate length in *G. blattarum*. There is a perceptible constriction of both primite and satellite in *G. blattarum*, none in *G. thomasi*.

The same differences are found when *G. thomasi* is compared with *G. illinensis* Watson, which has a primite protomerite which is broadly rounded and almost spherical, and which has perceptible constrictions of both primite and satellite. A number of lesser differences may be noted.

Gregarina parcoblattae n. sp. (Plate I, Figs. 9, 10, and 11.)

Hosts: *Parcoblatta uhleriana* (Saussure); *P. pensylvanica* (DeGeer).

Habitat: Mid-intestine.

Distribution: Fairfield and Washington Counties, Ohio.

Description: The primite protomerite of the organism is flattened and regularly or irregularly rounded; the deutomerite is cylindric. The satellite protomerite is flattened, and the deutomerite is cylindric. There is a marked constriction at the septum of both primite and satellite. The epicyte and sarcocyte of the association are apparently extremely thin. The endoplasm of the association is very opaque, and is white in reflected light. The nuclei are spherical and contain no karyosomes.

The measurements are as follows: Length and width of primite protomerite, 90 to 130μ, by 143 to 208μ, averaging 112 by 174μ; of primite deutomerite, 390 to 553μ by 215 to 325μ, averaging 474 by 267μ; of satellite protomerite, 59 to 97μ by 112 to 260μ, averaging 78.5 by 185.5μ; of satellite deutomerite, 443 to 650μ by 214 to 390μ, averaging 549.5 by 289μ. Total length of primite, 480 to 683μ, averaging 586μ. Total length of association, 982 to 1430μ, averaging 1214μ. Diameter of primite nucleus, 45 to 65μ, averaging 55; of satellite nucleus, 45 to 65μ, averaging 58μ. Nuclei were sometimes invisible because of the opacity of the cell.

The proportions are as follows: Length of primite protomerite to total length varies from 1 : 5.0 to 1 : 5.6, averaging 1 : 5.3; of satellite, 1 : 6.7 to 1 : 9.1, averaging 1 : 8.0. Width of primite protomerite to width of deutomerite varies from 1 : 1.4 to 1 : 1.8, averaging 1 : 1.6; of satellite, 1 : 1.2 to 1 : 1.8, averaging 1 : 1.5.

The movement is slow, without flexion. The organism is often attached posteriorly to debris.

Two cysts were observed. These were 290μ in diameter, or 475μ including the transparent outer layer. They were very opaque and were white in reflected light. Dehiscence was not observed. No other stages were recognized.

Affinities: This organism resembles *Gregarina blattarum* Siebold, Watson variety, differing as follows: The shape of the primite protomerite in *G. parcoblattae* n. sp. is flattened and broadly rounded, regularly or irregularly; that of *G. blattarum* is papillate. The deutomerites of *G. parcoblattae* are cylindric and square cornered; those

of *G. blattarum* are between cylindric and ovoid. Lesser differences can be seen.

Gregarina rigida columna n. subsp. (Plate I, Figs. 12 (?), 13.)

Hosts: *Arphia sulphurea* (Fabricius); *Chortophaga viridifasciata* (DeGeer); *Encoptolophus sordidus* (Burmeister); *Pardalophora apiculata* (Harris); *Dissosteira carolina* (Linnaeus); *Spharagemon bolli* Scudder; *S. collare collare* (Scudder); *Melanoplus obovatipennis* (Blatchley); *M. scudderi scudderi* (Uhler); *M. differentialis* (Thomas); *M. bivittatus* (Say); *M. mexicanus mexicanus* (Saussure); *M. keeleri luridus* (Dodge).

Habitat: Enteric ceca; mid-intestine.

Distribution: Gary, Indiana; Fairfield, Franklin, Licking, Union, and Washington Counties, Ohio.

Description: The primite protomerite of the organism is dome-like; the deutomerite is cylindric. The satellite protomerite is somewhat flattened and is often continuous with the deutomerite; the deutomerite is cylindric. There is very little or no constriction at the septum of either primite or satellite. The epicyte and sarcocyte, collectively, of the association vary from 4 to 20μ in thickness, usually being of uniform thickness throughout, but sometimes being much thicker in the primite protomerite. The endoplasm is moderately opaque and is yellow in reflected light. The nuclei are spherical and contain eight or more small karyosomes.

The measurements are as follows: Length and width of primite protomerite, 52 to 195μ by 85 to 214μ, averaging 117 by 157μ; of primite deutomerite, 165 to 780μ by 97 to 292μ, averaging 412 by 177μ; of satellite protomerite, 46 to 101μ by 85 to 219μ, averaging 60 by 141μ; of satellite deutomerite, 228 to 650μ by 85 to 210μ, averaging 384 by 147μ. Total length of primite, 217 to 975μ, averaging 529μ; of satellite, 274 to 751μ, averaging 444μ. Total length of association, 491 to 1726μ, averaging 973μ. Diameter of primite nucleus, 39 to 65μ, averaging 58μ; of satellite nucleus, 39 to 67μ, averaging 52μ.

The proportions are as follows: Length of primite protomerite to total length varies from 1 : 3.7 to 1 : 6.1, averaging 1 : 5.5; of satellite, 1 : 5.0 to 1 : 7.7, averaging 1 : 6.1. Width of primite protomerite to width of deutomerite varies from 1 : 1.0 to 1 : 1.2, averaging 1 : 1.1; of satellite, 1 : 0.9 to 1 : 1.2, averaging 1 : 1.0.

The movement is slow and deliberate, without flexion.

For other stages in the life history, see *Gregarina rigida rigida* (Hall).

Affinities: This organism closely resembles *Gregarina rigida* (Hall), given in this paper as *G. rigida rigida* (Hall), differing from it as follows: The primite protomerite of *G. r. columna* is dome-like, almost as wide as that of the deutomerite, and has little or no constriction; that of *G. r. rigida* is flattened, usually much narrower than the deutomerite, and a constriction is always present, usually marked. The ratio of the width of the deutomerite to that of the protomerite was taken as the principal diagnostic character in setting apart these two subspecies. So far as can be determined from the illustrations of other investigators (most of the written descriptions are inadequate), the ratio 1 : 1.3 may be taken as the lower limit for *G. r. rigida*, Watson (1916a, 105) giving 1 : 1.4 as that of the typical organism. The mean width ratio of all

specimens of *G. r. rigida* observed in this study was 1 : 1.5. Ten percent of these showed a ratio of 1 : 1.3; ten percent 1 : 1.4; six percent 1 : 1.5; twelve percent 1 : 1.7 and four percent 1 : 1.8. The mean width ratio of all specimens of *G. r. columna* was 1 : 1.1 with eleven percent showing 1 : 1.0; twenty-six percent 1 : 1.1 and twenty-one percent 1 : 1.2.

Aside from the mean width ratios (not conclusive in themselves), a factor that might tend to support a distinction between the two subspecies is the fact that they are seldom found in the same individual host. Also, a distinctive tendency in some of the individuals of the 1 : 1.0 to 1.2 range is a lengthening of the protomerite of the primite, the ratio approximating 1 : 1 (length to width) in three of those observed, two of them with the 1 : 1.1 width ratio, and one with the 1 : 1.2.

The intergrading individuals represent a link between the two subspecies which makes it inadvisable at the present to raise *G. r. columna* n. subsp. to the specific rank.

Gregarina rigida rigida (Hall, 1907) Ellis, 1913. (Plate I, Fig. 14.)

References: Hall, 1907, 150, 169, etc.; Crawley, 1907, 223; Sokolow, 1911, 279; Wellmer, 1911, 108; Ellis, 1913a, 464; Ellis, 1913b, 82; Ellis, 1913c, 267; Watson, 1915, 34; Watson, 1916a, 105; Kamm, 1920, 23.

Synonymy: *Hirmocystis rigida* Hall, 1907, 150, 169, etc.; *Gregarina melanopli* Crawley, 1907, 223; *Gregarina rigida* Ellis, 1913c, 267; *Gregarina rigida rigida* n. subsp.

Hosts: *Chorthippus curtipennis curtipennis* (Harris); *Arphia sulphurea* (Fabricius); **Encoptolophus sordidus* (Burmeister); *Dissosteira carolina* (Linnaeus); *Spharagemon bolli* Scudder; **Brachystola magna* (Girard); **Schistocerca americana americana* (Drury); **Hesperotettix viridis pratensis* (Scudder); *Melanoplus obovatipennis* (Blatchley); ***M. differentialis* (Thomas); ***M. bivittatus* (Say); ***M. femur-rubrum femur-rubrum* (DeGeer); ***M. mexicanus mexicanus* (Saussure); ** *M. keeleri luridus* (Dodge); **M. angustipennis* (Dodge).

Habitat: *Alimentary canal; gizzard; **enteric ceca; mid-intestine.

Distribution: *Canon City and Colorado Springs, Colorado; *Urbana, Illinois; Gary, Indiana; *Douglas Lake, Michigan; *Lincoln, Nebraska; *Oyster Bay, New York; Fairfield, Franklin, Licking, and Washington Counties, Ohio; *Wyncote, Pennsylvania.

Description: The primite protomerite of the organism is flattened and broadly rounded; the deutomerite is cylindric. The satellite protomerite is flattened and the deutomerite cylindric. There is a marked constriction at the septa. The epicyte and sarcocyte, collectively, are very thin and of even thickness throughout, except occasionally in the primite protomerite, where they may become as much as 20μ in thickness. The endoplasm of the association is moderately opaque, and is yellow in reflected light. The nuclei are spherical,

*Of other investigators only.

**Of the author as well as of other investigators.

Unstarred information is of the author only.

containing 1 to 10 karyosomes, the exact number being difficult to determine because of the opacity of the nucleus.

The measurements are as follows: Length and width of primite protomerite, 52 to 130μ by 72 to 170μ, averaging 88 by 122μ; of primite deutomerite, 163 to 468μ by 124 to 280μ, averaging 288 by 177μ; of satellite protomerite, 39 to 71μ by 72 to 208μ, averaging 58 by 127μ; of satellite deutomerite, 182 to 650μ by 97 to 260μ, averaging 325 by 181μ. Total length of primite, 215 to 598μ, averaging 376μ; of satellite, 221 to 721μ, averaging 383μ. Total length of association, 436 to 1319μ, averaging 759μ. Diameter of primite nucleus, 39 to 78μ, averaging 52μ; of satellite nucleus, 33 to 78μ, averaging 53μ.

The proportions are as follows: Length of primite protomerite to total length varies from 1 : 3.7 to 1 : 5.9, averaging 1 : 4.3; of satellite, 1 : 3.9 to 1 : 11.0, averaging 1 : 6.7. Width of primite protomerite to width of deutomerite varies from 1 : 1.3 to 1 : 1.8, averaging 1 : 1.5; of satellite, 1 : 1.3 to 1 : 1.7, averaging 1 : 1.45.

No movement was observed. The organisms are usually attached posteriorly to debris.

Numerous cephalonts were observed. Each possessed a globular epimerite. Cysts, averaging 260μ in diameter, or 325μ, including the transparent outer layer, were seen. These were very opaque, and were shades of yellow in reflected light. (It was impossible to determine whether the cephalonts and cysts were of this subspecies or of *G. rigida columna* n. subsp.) Dehiscence of cysts was not observed.

Affinities: See *Gregarina rigida columna* n. subsp.

Gregarina indianensis n. sp. (Plate I, Figs. 15 and 16.)

Hosts: *Chorthippus curtipennis* (Harris); *Melanoplus differentialis* (Thomas); *M. bivittatus* (Say); *M. mexicanus mexicanus* (Saussure).

Habitat: Enteric ceca; mid-intestine.

Distribution: Gary, Indiana.

Description: The primite protomerite of the organism is cylindric to conic, and is truncated anteriorly; the anterior end is invaginated. The primite deutomerite is cylindric. The satellite protomerite approximates that of the primite in shape; the deutomerite is cylindric to tapering posteriorly, ending bluntly. There is little or no constriction at the septum of the primite; that of the satellite is slight. The epicyte and sarcocyte, collectively, are extremely thin throughout. The endoplasm of the association is moderately opaque, and is shades of yellow in reflected light. The nuclei are spherical and each possesses two large karyosomes.

The measurements are as follows: Length and width of primite protomerite, 97 to 151μ by 85 to 124μ, averaging 128 by 101μ; of primite deutomerite, 228 to 357μ by 104 to 176μ, averaging 316 by 133μ; of satellite protomerite, 65 to 97μ by 97 to 124μ, averaging 78 by 114μ; of satellite deutomerite, 221 to 338μ by 118 to 130μ, averaging 294 by 124μ. Total length of primite, 325 to 508μ, averaging 444μ; of satellite, 286 to 435μ, averaging 372μ. Total length of association, 611 to 943μ, averaging 816μ. Diameter of each nucleus, 44 to 52μ, averaging 48μ.

The proportions are as follows: Length of primite protomerite to total length varies from 1 : 3.4 to 1 : 3.8, averaging 1 : 3.5; of satellite, 1 : 4.0 to 1 : 6.2, averaging 1 : 4.85. Width of primite protomerite to width of deutomerite varies from 1 : 1.2 to 1 : 1.4, averaging 1 : 1.3; of satellite, 1 : 1.0 to 1 : 1.3, averaging 1 : 1.1.

No movement was observed. The organisms are usually attached posteriorly to debris.

Cephalonts were very numerous. Each has a cylindrical epimerite, terminating bluntly. The protomerite is wider at the anterior end than at the base, presenting every gradation from this condition to that of the adult. No additional stages in the life history were recognized.

Affinities: This organism bears a marked resemblance to *Gregarina nigra* Watson, 1915 and possibly there is a close relationship between them. The differences are as follows: The primite protomerite of *G. nigra* has a minute indentation at the apex; that of *G. indianensis* has the anterior end depressed. The epicyte is thickened at the anterior end of the protomerite in *G. nigra*, very thin throughout in *G. indianensis*. The nucleus of *G. nigra* contains many karyosomes and is not visible in vivo; that of *G. indianensis* contains two (rarely three) karyosomes and is visible in vivo. The endoplasm of *G. nigra* is more opaque than that of *G. indianensis*.

It is interesting to add here that Bush (1928, 153) describes a *Legeria* sp. from Natal (U. S. Africa) that very closely resembles the immature sporonts of *G. indianensis*. Also he describes an organism which he identifies as *G. nigra* which might be a close relative of *G. indianensis*. It would follow, then, that *Legeria* sp. Bush, 1928 might be the immature sporont of *G. nigra*, Natal variety. Apparently neither Watson nor Bush recognized the immature sporonts of *G. nigra*.

Gregarina nigra Watson, 1915. (Plate I, Fig. 17.)

References: Watson, 1915, 33; Watson, 1916a, 116; Kamm, 1922a, 130; Kamm, 1922b, 84; Bush, 1928, 154 et al.

Synonymy: Name unchanged.

Hosts: **Encoptolophus sordidus* (Burmeister); *Zonocerus elegans* (Thunberg); **Lentula* sp.; **Cyrtacanthacris ruficornis* (Fabricius); **Melanoplus differentialis* (Thomas); ***M. femur-rubrum femur-rubrum* (DeGeer).

Habitat: *Alimentary canal; mid-intestine.

Distribution: *Pietermaritzburg, Natal; *Urbana, Illinois; Washington County, Ohio.

Description: The primite protomerite of the organism is conic, with a small pit at the apex; the deutomerite is cylindric except at the extreme posterior end, where it becomes swollen. The satellites were immature (see illustration). There is no constriction at the septum of the primite and little at that of the satellites. The epicyte and sarcocyte, collectively, are extremely thin, without the characteristic thickening at the anterior end described by Watson. (It should be noted that the

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**Of the author as well as of other investigators.
Unstarred information is of the author only.

only specimen of this species recognized was an association of three sporonts; one atypically elongate primite and two small satellites—a condition rarely observed in *Gregarina*.) The endoplasm of the primite is very opaque, and is yellow in reflected light; that of the satellites is translucent and practically colorless in reflected light. The nucleus of the primite was invisible, those of the satellites spherical, possessing many karyosomes.

The measurements are as follows: Length and width of primite protomerite, 75 by 80μ; of primite deutomerite, 425 by 100μ; of satellite protomerite 25 by 35 to 40μ; of satellite deutomerite, 125 to 140μ by 35 to 40μ, averaging 132.5 by 37.5μ. Total length of primite, 500μ; of satellite, 150 to 165μ, averaging 137.5μ. Total length of association, 637.5μ. Diameter of satellite nuclei, 15 to 18μ, averaging 16.5μ.

The proportions are as follows: Length of primite protomerite to total length, 1 : 6.7; of satellite, 1 : 6.0 to 1 : 6.6, averaging 1 : 6.3. Width of primite protomerite to width of deutomerite, 1 : 1.25; of satellite, 1 : 1.0.

No movement was observed.

No other stages in the life history were recognized.

Gregarina locustae Lankester, 1863. (Plate I, Fig. 18.)

References: Leidy, 1853a, 239; Leidy, 1856, 47; Diesing, 1859, 730; Lankester, 1863, 94; Léger, 1897, 10; Labbé, 1899, 35; Crawley, 1903a, 54; Crawley, 1903b, 640; Crawley, 1907, 225; Ellis, 1913c, 268; Watson, 1916a, 100.

Synonymy: *Gregarina Locustae Carolinae* Leidy, 1853a, 239; *G. Locustae Carolinae* Leidy, 1856, 47; *G. fimbriata* Diesing, 1859, 730; *G. Locustae* Lankester, 1863, 94; *G. locustaecarolinae* Labbé, 1899, 35; *Stephanophora locustaecarolinae*† Crawley, 1903a, 54; *G. locustaecarolinae* Crawley, 1907, 225; *G. locustae* Watson, 1916a, 100.

Hosts: ***Dissosteira carolina* (Linnaeus).

Habitat: *Alimentary canal; mid-intestine.

Distribution: Gary, Indiana; *Wyncote, Pennsylvania.

Description: The primite protomerite of the organism is greatly flattened and narrow; the deutomerite is cylindric. The satellite protomerite is similar to that of the primite, but is not flattened to the same extent; the deutomerite is cylindric. There is a marked constriction at the septum of both primite and satellite. The epicyte and sarcocyte of the association are extremely thin. The endoplasm is translucent, and is white in reflected light. The nuclei are spherical, with one karyosome each.

The measurements are as follows: Length and width of primite protomerite, 45 by 111μ; of primite deutomerite, 280 by 176μ; of satellite protomerite, 59 by 97μ; of satellite deutomerite, 280 by 163μ. Total length of primite, 325μ; of satellite, 339μ. Total length of association, 664μ. Diameter of nuclei (primite and satellite), 46μ.

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*Of other investigators only.

**Of the author as well as of other investigators.

Unstarred information is of the author only.

†One word.

The proportions are as follows: Length of primite protomerite to total length, 1 : 7.2; of satellite, 1 : 5.7. Width of primite protomerite to width of deutomerite, 1 : 1.6; of satellite, 1 : 1.7.

No movement was observed.

No other stages in the life history were recognized.

Gregarina kingi Crawley, 1907. (Plate I, Fig. 19.)

References: Crawley, 1907, 221; Sokolow, 1911, 279; Ellis, 1913c, 271; Watson, 1916a, 106.

Synonymy: *Gregarina kingi* Crawley, 1907, 221; *Gigaductus kingi* Ellis, 1913c, 271.

Hosts: ****Gryllus assimilis*** Fabricius.

Habitat: *Alimentary canal; gizzard; enteric ceca; mid-intestine.

Distribution: *Beach Haven, New Jersey; Franklin and Washington Counties, Ohio; *Wyncote, Pennsylvania.

Description: The primite protomerite of the organism is dilated anteriorly and constricted at or below the middle; the deutomerite is a modified cylinder. The satellite protomerite is elongate and the deutomerite, cylindric to tapering posteriorly. There is a marked constriction at the septa. The epicyte and sarcocyte, collectively, are extremely thin throughout. The endoplasm is translucent, and is white in reflected light. The nuclei are spherical and contain one large karyosome each.

The measurements are as follows: Length and width of primite protomerite, 48 to 52μ by 32 to 34μ, averaging 50 by 33μ; of primite deutomerite, 91 to 100μ by 32 to 34μ, averaging 95.5 by 33μ; of satellite protomerite, 20 to 25μ by 35 to 38μ, averaging 22.5 by 36.5μ; of satellite deutomerite, 59 to 65μ by 35 to 38μ, averaging 62 by 36.5μ. Total length of primite, 139 to 152μ, averaging 145.5μ; of satellite, 79 to 90μ, averaging 84.5μ. Total length of association, 218 to 242μ, averaging 230μ. Diameter of nuclei (primite and satellite) 13 to 15μ, averaging 14μ.

The proportions are as follows: Length of primite protomerite to total length varies from 1 : 2.8 to 1 : 3.1, averaging 1 : 2.95; of satellite, 1 : 3.6 to 1 : 3.9, averaging 1 : 3.75. Width of primite protomerite to width of deutomerite, 1 : 1.0; of satellite, 1 : 1.0.

Movement was not observed. All of the organisms were attached to debris, usually posteriorly.

No other stages in the life history were recognized.

Gregarina galliveri Watson, 1915. (Plate I, Fig. 20.)

References: Watson, 1915, 33; Watson, 1916a, 111; Kamm, 1922a, 130; Kamm, 1922b, 84.

Synonymy: Name unchanged.

Hosts: ****Gryllus assimilis*** Fabricius; ***Hapithus agitator agitator*** Uhler.

Habitat: *Alimentary canal; crop and gizzard; enteric ceca; mid-intestine.

Distribution: *Oyster Bay, New York; Franklin and Washington Counties, Ohio.

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*Of other investigators only.
**Of the author as well as of other investigators.
Unstarred information is of the author only.

Description: The primite protomerite of the adult is flattened and as wide as the deutomerite or wider; the deutomerite is cylindric, with undulation, to tapering posteriorly. The satellite protomerite is flattened and the deutomerite is cylindric to ellipsoid. There is little or no constriction at the septa. The epicyte and sarcocyte, collectively, are extremely thin throughout. The endoplasm of the association is moderately to considerably opaque and is shades of yellow in reflected light. The nuclei are spherical and contain no karyosomes.

The measurements are as follows: Length and width of primite protomerite, 30 to 52μ by 52 to 130μ, averaging 37.5 by 88μ; of primite deutomerite, 65 to 195μ by 45 to 104μ, averaging 144 by 74μ; of satellite protomerite, 26 to 45μ by 45 to 97μ, averaging 33 by 72.5μ; of satellite deutomerite, 85 to 247μ by 52 to 130μ, averaging 165 by 92μ. Total length of primite, 95 to 247μ, averaging 181.5μ; of satellite, 111 to 292μ, averaging 198μ. Total length of association, 206 to 539μ, averaging 379.5μ. Diameter of primite nucleus, 15 to 32μ, averaging 22μ; of satellite nucleus, 15 to 30μ, averaging 20μ.

The proportions are as follows: Length of primite protomerite to total length varies from 1 : 3.1 to 1 : 7.1, averaging 1 : 5.0; of satellite, 1 : 3.7 to 1 : 8.8, averaging 1 : 6.0. Width of primite protomerite to width of deutomerite varies from 1 : 0.65 to 1 : 1.0, averaging 1 : 1.0; of satellite, 1 : 1.0 to 1 : 1.5, averaging 1 : 1.2.

No movement was observed. All of the organisms were attached posteriorly to debris.

No other stages in the life history were recognized.

Comment: M. E. Watson (1916a, 111) states that the primite protomerite is always wider than the primite deutomerite. In approximately 25% of those examined in this study (from the same species of host) the widths of the two parts were the same.

Gregarina hadenoeci n. sp. (Plate I, Fig. 21; Plate II, Fig. 22.)

Hosts: *Hadenoecus puteanus* Scudder.

Habitat: Mid-intestine.

Distribution: Washington County, Ohio.

Description: The primite protomerite of the organism is a depressed sphere; the deutomerite is slightly tapering posteriorly. The satellite protomerite is a depressed sphere; the deutomerite is modified top-like. There is a very deep constriction at the septum of both primite and satellite. The epicyte and sarcocyte, collectively, are extremely thin. The endoplasm of the association is translucent, and is almost colorless in reflected light. The nuclei are spherical and have no karyosomes.

The measurements are as follows: Length and width of primite protomerite, 52 to 65μ by 71 to 100μ, averaging 58.5 by 85.5μ; of primite deutomerite, 162 to 227μ by 85 to 123μ, averaging 194.5 by 104μ; of satellite protomerite, 39μ by 65 to 91μ (average of latter, 78μ); of satellite deutomerite, 111 to 260μ by 85 to 150μ, averaging 185 by 117.5μ. Total length of primite, 214 to 292μ, averaging 253μ; of satellite, 150 to 299μ, averaging 225μ. Total length of association, 364 to 591μ, averaging 477μ. Diameter of primite nucleus, 25 to 26μ, averaging 25.5μ; of satellite nucleus (one visilbe), 26μ.

The proportions are as follows: Length of primite protomerite to total length varies from 1 : 4.1 to 1 : 4.5, averaging 1 : 4.3; of satellite, 1 : 4.8 to 1 : 7.7, averaging 1 : 6.25. Width of primite protomerite to width of deutomerite, 1 : 1.2; of satellite, 1 : 1.3 to 1 : 1.6, averaging 1 : 1.45.

No movement was observed.

Fourteen smaller sporonts were observed which were more top-like than the satellites (see illustration). No other stages were recognized.

Affinities: This organism resembles *Gregarina stygia* Watson, 1915, differing from it as follows: Sporonts of *Gregarina hadenoeci* n. sp. are tapering and top-like; those of *G. stygia* are barrel-shaped. The primite protomerite of *G. hadenoeci* is a depressed sphere; that of *G. stygia* is hemispherical. There is a deep constriction of the primite in *G. hadenoeci*, little in *G. stygia*. In *G. hadenoeci* the satellite deutomerite is wider than the primite deutomerite; in *G. stygia* it is usually narrower. Other minor differences may be noted.

Gregarina proteocephala n. sp. (Plate II, Figs. 23, 24, 25.)

Hosts: *Ceuthophilus gracilipes* (Haldeman).

Habitat: Mid-intestine.

Distribution: Washington County, Ohio.

Description: The primite protomerite of the organism is protean, exhibiting a deep, anterior, cup-like depression; the deutomerite is barrel-shaped to slightly tapering posteriorly. The satellite protomerite is continuous with the deutomerite, the two combined compartments forming an ellipse. The degree of constriction at the primite septum varies with the protean activity of the protomerite; there is little or no constriction at the satellite septum. The epicyte and sarcocyte, collectively, are of even thickness throughout, varying from 6.5μ down to an extremely thin layer. The endoplasm of the association is moderately to considerably opaque and is white in reflected light. The nuclei are spherical and possess no karyosomes.

The measurements are as follows: Length and width of primite protomerite vary greatly as a result of the protean activity. (See illustration.) Length and width of primite deutomerite, 111 to 195μ by 91 to 150μ, averaging 137 by 108μ; of satellite protomerite, 39 to 97μ by 85 to 150μ, averaging 165 by 113μ. Total length of primite, approximately 150 to 312μ, averaging 205μ; of satellite, 169 to 357μ, averaging 227μ. Total length of association, approximately 319 to 669μ, averaging 432μ. Diameter of nuclei, 32 to 39μ, averaging 33μ.

The proportions are as follows: Length of satellite protomerite to total length varies from 1 : 3.2 to 1 : 4.5, averaging 1 : 3.7. Width of satellite protomerite to width of deutomerite varies from 1 : 1.0 to 1 : 1.2, averaging 1 : 1.05.

The movement is slow with much torsion and flexion; that of the primite protomerite is almost ameboid.

Seven immature sporonts, six retaining epimerites, were observed. They were not found in the same specimens (but were in the same species of host), but did not resemble sporonts of the only other gregarinid (*Gregarina ceuthophili* n. sp.) recognized by the author from the same

species of host. The epimerite was a short, blunt cylinder (see illustration). (M. E. Watson, 1916a, 115, states that the epimerite of *Gregarina stygia* Watson, which probably came from the same host, is knobbed and slightly stalked.) The entire cephalont, or immature sporont, was very translucent.

Affinities: This organism resembles the gregarinid parasites of the ceuthophili, particularly *Gregarina longiducta* Ellis, but may be definitely set apart from all of them by the protean activity of the primite protomerite.

Comment: It is interesting to note that this gregarinid was taken from four of twelve specimens of *Ceuthophilus gracilipes* (Haldeman) from Washington County, Ohio, but from none of the forty-four specimens of the same species of insect taken in Fairfield County, Ohio.

Gregarina species. (Plate II, Fig. 26.)

Hosts: *Ceuthophilus divergens* Scudder.

Habitat: Mid-intestine.

Distribution: Franklin County, Ohio.

Description: The primite protomerite of the organism is an elongate hemisphere, and the deutomerite is ovoid. The satellite protomerite is hemispherical and the deutomerite ovoid. There is little constriction at the septa. The epicyte and sarcocyte were not recognized, hence they are probably very thin. The endoplasm of the association is opaque, and is white in reflected light. The nuclei were not visible.

The measurements are as follows: Length and width of primite protomerite, 45 by 52μ; of primite deutomerite, 156 by 65μ; of satellite protomerite, 36 by 43μ; of satellite deutomerite, 90 by 59μ. Total length of primite, 191μ; of satellite, 126μ. Total length of association, 317μ.

The proportions are as follows: Length of primite protomerite to total length, 1 : 4.2; of satellite, 1 : 3.5. Width of primite protomerite to width of deutomerite, 1 : 1.3; of satellite, 1 : 1.4.

No movement was observed.

No other stages were recognized.

Affinities: This organism resembles *Gregarina consobrina* Ellis, differing from it in the length to width ratio of the deutomerites. In *Gregarina* sp. length of deutomerites is over twice the width; in *G. consobrina* length and width are approximately equal.

Comment: Insufficient characterization makes it inadvisable to name the apparently new species at this time.

Gregarina ceuthophili n. sp. (Plate II, Figs. 27 to 30.)

Hosts: *Ceuthophilus gracilipes* (Haldeman); *C. brevipes* Scudder; *C. divergens* Scudder.

Habitat: Mid-intestine.

Distribution: Fairfield, Franklin, Licking, and Washington Counties, Ohio.

Description: The primite protomerite of the organism is polymorphic, varying from an irregular hemisphere to a cone with a blunt apex; the deutomerite is ellipsoid to tapering anteriorly. The satellite

protomerite is almost hemispherical and is continuous with the deutomerite; the latter is ovoid and elongate, sometimes with marked posterior tapering. There is a marked constriction at the primite septum; none at the satellite septum. The epicyte and sarcocyte, collectively, are usually extremely thin, but may occasionally be as much as three microns in the primite protomerite. The endoplasm of the association is translucent to moderately opaque, and is white in reflected light. The nuclei are spherical, each containing one large karyosome.

The measurements are as follows: Length and width of primite protomerite, 28 to 59μ by 45 to 71μ, averaging 45 by 62μ; of primite deutomerite, 111 to 265μ by 60 to 117μ, averaging 200 by 92.5μ; of satellite protomerite, 20 to 39μ by 45 to 111μ, averaging 33 by 85.5μ; of satellite deutomerite, 95 to 337μ by 52 to 111μ, averaging 249 by 94μ. Total length of primite, 139 to 324μ, averaging 245μ; of satellite, 115 to 376μ, averaging 282μ. Total length of association, 254 to 700μ, averaging 527μ. Diameter of primite nucleus, 25 to 39μ, averaging 33μ; of satellite nucleus, 25 to 45μ, averaging 36μ.

The proportions are as follows: Length of primite protomerite to total length varies from 1 : 5.0 to 1 : 6.0, averaging 1 : 5.4; of satellite, 1 : 5.7 to 1 : 9.6, averaging 1 : 8.2. Width of primite protomerite to width of deutomerite, 1 : 1.25 to 1 : 1.7, averaging 1 : 5.0; of satellite, 1 : 1.0 to 1 : 1.3, averaging 1 : 1.1.

The movement is rapid and in a straight line.

Numerous immature sporonts were recognized. They are characterized by the shape of the protomerite (a depressed sphere) and an elongate and tapering deutomerite. Several intergradations between this condition and that of the associated sporonts were observed. Ten cysts (same species?) were observed. These were spherical and averaged 215μ in diameter, not including the transparent outer layer, which was 30μ in thickness. Three cysts, kept in a thin film of water in a moist chamber, were reduced approximately 80μ in diameter, and were attacked by a mold after three days of observation. Dehiscence failed to take place. No other stages were recognized.

Affinities: This organism resembles several of the gregarinid parasites of the ceuthophili, particularly *Gregarina neglecta* Watson, differing from it as follows: The primite protomerite of *G. ceuthophili* n. sp. is irregularly hemispherical to conic with a blunt apex; that of *G. neglecta* is cap-like, very short and continuous with the deutomerite, and papillate at the apex. *G. ceuthophili* may have a marked constriction at the septum; *G. neglecta* has little or no constriction. The satellite deutomerite is elongate in *G. ceuthophili;* obese in *G. neglecta.* Minor differences may be noted.

Gregarina prima n. sp. (Plate II, Fig. 31.)

Hosts: *Ceuthophilus uhleri* Scudder.

Habitat: Mid-intestine.

Distribution: Fairfield and Logan Counties, Ohio.

Description: The primite protomerite of the organism is a depressed hemisphere; the deutomerite is cylindric to ovoid. The satellite

protomerite is flattened and the deutomerite cylindric. A thick hyaline connective is present between the primite and satellite—a condition unique among the gregarinids described in this paper. There is a slight constriction at the septum of the primite, a deep one at that of the satellite. The epicyte and sarcocyte, collectively, are extremely thin. The endoplasm of the association is moderately opaque, and is white in reflected light. The nuclei are spherical and contain no karyosomes.

The measurements are as follows: Length and width of primite protomerite, 30 to 66μ by 48 to 52μ, averaging 49 by 51μ; of primite deutomerite, 77 to 127μ by 57 to 97μ, averaging 108 by 78μ; of satellite protomerite, 18 to 30μ by 52 to 60μ, averaging 23 by 55μ; of satellite deutomerite, 97μ by 75 to 77μ (average of latter, 76μ). Length of primite, 107 to 193μ, averaging 157μ; of satellite, 115 to 127μ, averaging 120μ. Total length of association, 222 to 320μ, averaging 277μ. Diameter of nuclei, 14 to 19μ, averaging 16μ.

The proportions are as follows: Length of primite protomerite to total length varies from 1 : 2.8 to 1 : 3.5, averaging 1 : 3.3; of satellite, 1 : 4.2 to 1 : 6.4, averaging 1 : 5.3. Width of primite protomerite to width of deutomerite varies from 1 : 1.5 to 1 : 1.9, averaging 1 : 1.7; of satellite, 1 : 1.25 to 1 : 1.5, averaging 1 : 1.4.

No movement was observed.

No additional stages were recognized.

Affinities: This organism resembles *Gregarina udeopsyllae* Watson, differing from it as follows: The primite protomerite of *G. prima* is a depressed hemisphere; that of *G. udeopsyllae* is papillate. *G. prima* has little constriction at the septum of the primite; *G. udeopsyllae* has a marked constriction. Minor differences may be noted.

Gregarina acrydiinarum n. sp. (Plate II, Figs. 32 to 35.)

Hosts: *Acrydium arenosum angustum* Hancock; *Paratettix cucullatus cucullatus* (Burmeister).

Habitat: Mid-intestine.

Distribution: Delaware and Franklin Counties, Ohio.

Description: The primite protomerite of the organism is somewhat protean, but is usually cylindric, terminating bluntly; the deutomerite is ovoid to cylindric. The satellite protomerite is flattened almost to the point of obliteration; the deutomerite is ellipsoid to cylindric. There is a marked constriction at each of the septa. The epicyte and sarcocyte, collectively, are extremely thin. The endoplasm of the association is translucent and is shades of yellow to orange in reflected light. The nuclei are spherical and contain no karyosomes.

The measurements are as follows: Length and width of primite protomerite, 26 to 45μ by 32 to 52μ, averaging 36 by 40μ; of primite deutomerite, 104 to 169μ by 65 to 136μ, averaging 137 by 96μ; of satellite protomerite (omitting length, which is negligible), 30 to 54μ (width), averaging 47μ; of satellite deutomerite, 143 to 208μ by 70 to 143μ, averaging 174 by 96μ. Length of primite, 130 to 214μ, averaging 173μ; of satellite, 143 to 208μ, averaging 174μ. Total length of association, 273 to 422μ, averaging 347μ. Diameter of nuclei, 23 to 32μ, averaging 29μ.

The proportions are as follows: Length of primite protomerite to total length varies from 1 : 4.3 to 1 : 6.1, averaging 1 : 4.9. Width of primite protomerite to width of deutomerite varies from 1 : 2.0 to 1 : 2.6, averaging 1 : 2.4; of satellite, 1 : 1.3 to 1 : 2.8, averaging 1 : 2.1.

The movement of the organism as a whole is a very slow gliding with some flexion. The primite protomerite is protean to the extent of bending and wrinkling like the flexible snout of some mammals. It always becomes cheese-box-like (Fig. 35) when fixed and stained.

Six cysts, spherical and of the same color as the sporonts, were observed, but were mashed under the cover-slip. This was the only time which this accident occurred with the cysts of gregarinids, which are usually very resistant. No other stages were recognized.

Affinities: This organism somewhat resembles *Gregarina ovata* Dufour, differing from it chiefly as follows: The primite protomerite of *G. acrydiinarum* is cylindric; that of *G. ovata* is a depressed sphere. The satellite protomerite of *G. acrydiinarum* is almost obliterated; that of *G. ovata* is somewhat flattened. The satellite deutomerite of *G. acrydiinarum* is ellipsoid to cylindric; that of *G. ovata* is ovoid.

Gregarina oviceps Diesing, 1859. (Plate II, Fig. 36.)

References: Leidy, 1853a, 238; Leidy, 1856, 47; Diesing, 1859, 728; Lankester, 1863, 94; Labbé, 1899, 35; Crawley, 1903a, 45; Crawley, 1903b, 639; Crawley, 1907, 220; Ellis, 1913c, 266; Watson, 1915, 34; Watson, 1916a, 101; Bhatia and Setna, 1924, 287.

Synonymy: *Gregarina Achetae abbreviatae* Leidy, 1853a, 238; *G. oviceps* Diesing, 1859, 728; *G. Achetae* Lankester, 1863, 94; *G. achetaeabbreviatae* Labbé, 1899, 35; *G. achetae-abbreviatae* Crawley, 1907, 220.

Hosts: ***Gryllus assimilis* Fabricius; **Gryllus* spp.

Habitat: *Alimentary canal; **gizzard; **mid-intestine.

Distribution: *Lahore, India; *Urbana, Illinois; *Douglas Lake, Michigan; *Beach Haven, New Jersey; *Oyster Bay, New York; Franklin and Washington Counties, Ohio; *Haverford, Philadelphia, and Wyncote, Pennsylvania.

Description: The primite protomerite of the organism is flattened and wide; the deutomerite is ovoid and obese. The satellite protomerite is a modified hemisphere; the deutomerite ovoid and obese. There is a marked constriction at the septum of the primite, little at that of the satellite. The epicyte and sarcocyte, collectively, of the association are extremely thin. The endoplasm of the association is very opaque and is white to yellowish in reflected light. The nuclei were not visible.

The measurements are as follows: Length and width of primite protomerite, 65 to 71μ by 150 to 180μ, averaging 68 by 165μ; of primite deutomerite, 150 to 195μ by 160 to 180μ, averaging 177.5 by 170μ; of satellite protomerite, 70 to 71μ by 105 to 117μ, averaging 70.5 by 111μ; of satellite deutomerite, 175 to 228μ by 160 to 193μ, averaging 201.5 by 172.5μ. Length of primite, 215 to 266μ, averaging 245.5μ; of satellite,

*Of other investigators only.
**Of the author as well as of other investigators.
Unstarred information is of the author only.

245 to 299μ, averaging 272μ. Total length of association, 460 to 565μ, averaging 517.5μ.

The proportions are as follows: Length of primite protomerite to total length varies from 1 : 3.3 to 1 : 3.7, averaging 1 : 3.5; of satellite protomerite, 1 : 3.5 to 1 : 3.7, averaging 1 : 3.6. Width of primite protomerite to width of deutomerite varies from 1 : 1.0 to 1 : 1.01; of satellite, 1 : 1.5 to 1 : 1.6, averaging 1 : 1.55.

No movement was observed.

No other stages were recognized.

Pileocephalus tachycines n. sp. (Plate II, Figs. 37 to 39.)

Hosts: *Tachycines asinamorus* (Adelung).

Habitat: Mid-intestine.

Distribution: Franklin County, Ohio.

Description: The protomerite is usually a depressed hemisphere; the deutomerite is usually irregularly ovoid to cylindric. There is a marked to slight constriction at the septum. The epicyte and sarcocyte, collectively, are extremely thin. The endoplasm is very opaque and is white in reflected light. The nucleus is spherical and contains one very large karyosome.

The measurements are as follows: Length and width of protomerite, 16 to 39μ by 35 to 65μ, averaging 24 by 44μ; of deutomerite, 91 to 121μ by 55 to 85μ, averaging 106 by 64μ. Total length of the organism, 107 to 160μ, averaging 130μ. Diameter of nucleus, 20 to 32μ, averaging 26μ.

The proportions are as follows: Length of protomerite to total length varies from 1 : 3.8 to 1 : 6.8, averaging 1 : 5.5; width of protomerite to width of deutomerite varies from 1 : 1.3 to 1 : 1.6, averaging 1 : 1.5.

There is usually no movement; when it occurs it is very slow.

Three cephalonts were recognized. The epimerite is a modified cone, the protomerite a modified depressed hemisphere with apical depression and lateral constriction. One cyst was observed. This was spherical, 130μ in diameter (transparent envelope not present), very opaque, and white in reflected light. No additional stages were recognized.

Affinities: This organism resembles *Pileocephalus blaberae* (Frenzel), differing chiefly as follows: The epimerite of *P. tachycines* is a modified cone; that of *P. blaberae* is lance-like and swollen at the base. The sporont of *P. tachycines* is not over 160 microns in length; the average length of *P. blaberae* is 500 microns.

Actinocephalus species. (Plate II, Fig. 40.)

Hosts: *Pardalophora apiculata* (Harris).

Habitat: Mid-intestine.

Distribution: Washington County, Ohio.

Description: The "protomerite" is flattened and truncated; the "deutomerite" is a compressed sphere. (The tail-like posterior extension—see illustration—might have been a temporary cellular compression, as would be suggested by the presence of numerous parallel myoneme-like structures lying closely contiguous.) There is no con-

striction in the region of a possible septum. (Apparently this organism—one specimen observed—possesses no septum. The opacity would make it difficult to see the septum in vivo, but it failed to appear after the organism had been stained and permanently mounted.) The epicyte and sarcocyte, collectively, are about 3μ in thickness throughout. The endoplasm is very opaque, and is white in reflected light. The nucleus is a flattened sphere, containing 4 large karyosomes.

The measurements are as follows: Length and width of "protomerite," 110 by 195μ; of "deutomerite," 680 by 290μ. Total length of organism, 790μ. Size of nucleus, 78 by 97μ.

The proportions are as follows: Length of "protomerite" to total length, 1 : 7.2; width of "protomerite" to width of "deutomerite," 1 : 1.5.

The movement is a very slow gliding in a straight line.

No other stages were recognized.

Affinities: All known characters, except the apparent lack of a septum, would indicate a close relationship between this organism and the other actinocephali of Orthoptera.

Actinocephalus elongatus n. sp. (Plate II, Figs. 41 to 43.)

Hosts: *Dichromorpha viridis* (Scudder); *Arphia sulphurea* (Fabricius); *Chortophaga viridifasciata* (DeGeer); *Schistocerca americana americana* (Drury) (*A. elongatus* n. sp., ?); *Melanoplus mexicanus mexicanus* (Saussure) (*A. elongatus* n. sp. ?).

Habitat: Celom; enteric ceca; mid-intestine.

Distribution: Fairfield, Franklin, and Washington Counties, Ohio.

Description: The protomerite is usually a depressed hemisphere; the deutomerite is elongate, tapering irregularly to a blunt point. There is little or no constriction at the septum. The epicyte and sarcocyte, collectively, are from 6 to 26μ in thickness in the protomerite and about 6μ (average) in the deutomerite. The endoplasm is very opaque (usually black) and is white in reflected light. The nucleus is spherical and contains no karyosomes.

The measurements are as follows: Length and width of protomerite, 65 to 130μ by 130 to 202μ, averaging 100 by 163μ; of deutomerite, 306 to 682μ by 111 to 200μ, averaging 482 by 165μ. Total length of organism, 371 to 812μ, averaging 582μ. Diameter of nucleus, 45 to 62μ, averaging 54.5μ.

The proportions are as follows: Length of protomerite to total length varies from 1 : 5.0 to 1 : 7.5, averaging 1 : 5.8; width of protomerite to width of deutomerite varies from 1 : 0.9 to 1 : 1.2, averaging 1 : 1.0.

No movement was observed. The organism is usually attached posteriorly to debris.

One cephalont was observed. This possessed a broad epimerite with a number of short, finger-like processes (10 perceptible). No other stages were recognized.

Affinities: This organism resembles *Actinocephalus fimbriatus* (Diesing), differing as follows: The protomerite of *A. elongatus* is a depressed hemisphere; that of *A. fimbriatus* is an almost perfect sphere.

The deutomerite of *A. elongatus* is elongate, tapering irregularly to a blunt point; that of *A. fimbriatus* is ovoid, tapering slightly.

INFUSORIA

Nyctotherus ovalis Leidy, 1850, variety? (Plate II, Fig. 44.)

References: Siebold, 1839, 69; Leidy, 1850, 100; Leidy, 1853b, 244; Leidy, 1853c, 41; Stein, 1854, 42; Leidy, 1856, 43; Stein, 1856, 36; Claparède and Lachmann, 1858, 240; Stein, 1859, 78, 84, 85, 90; Stein, 1860, 50; Stein, 1862; Stein, 1867, 344; Leidy, 1879, 204; Grassi, 1881, 197; Schuster, 1898, 244; Belar, 1916, 242; Zulueta, 1916, 5; Kudo, 1922, 113; Yakimoff and Miller, 1922a, 9; Yakimoff and Miller, 1922b, 133; Pinto, 1926, 14; Tejera, 1926, 1382; Bhatia and Gulati, 1927, 86, 113, 116; Lucas, 1927, 224, 232; Lucas, 1928, 161; Weill, 1929, 22; McAdow, 1931, 16; Balch, 1932, 237.

Synonymy: "Leucophrys-artiges Infusorium" Siebold, 1839, 69; *Nyctotherus ovalis* Leidy, 1850, 100; *Bursaria blattarum* Stein, 1854, 42; *Plagiotoma Blattarum* Claparède and Lachmann, 1858, 240; *Plagiotoma blattarum* Stein, 1859, 78 et al.

Hosts: **Blattella germanica* (Linnaeus); *Parcoblatta pensylvanica* (DeGeer); **Blatta orientalis* Linnaeus; **Periplaneta americana* (Linnaeus); **Gryllotalpa gryllotalpa* Linnaeus; *undetermined species of woods-cockroaches.

Habitat: *Alimentary canal; *mid-intestine; **hind-intestine; *colon; *rectum.

Distribution: *Brazil; *London, England; *French Indo-China; *Berlin, Germany; *Lahore, India; *Urbana, Illinois; *Ohio; Champaign County, Ohio.

Description: The organism is ovoid in shape with cilia uniformly distributed over the body. Its measurements are 78 to 104μ by 104 to 136μ. The peristome starts just back of the anterior end, bending laterally to the right and paralleling the anterior end, and then extends posteriorly a little over half way down the organism. The peristome of the typical *N. ovalis* Leidy is at right angles to that of this organism, starting just back of the anterior end, extending posteriorly, then bending laterally to the left.

A cytostome was not visible.

A cytopyge is present at the extreme posterior end, extending somewhat laterally. It averages about 20μ in length.

One large vacuole (19μ, maximum diameter) is present, usually in the region of the cytopyge, sometimes farther anterior. Two or three smaller vacuoles, varying greatly in size, are scattered throughout the posterior half of the organism. These were not seen in vivo, hence it is not known which were contractile.

The macronucleus is usually elongate (about 19 by 45μ), somewhat dumb-bell shaped, with its longitudinal axis at right angles to that of

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*Of other investigators only.
**Of the author as well as of other investigators.
Unstarred information is of the author only.

the organism. The macronucleus of the typical *N. ovalis* approximates a fusiform appearance.

The micronucleus was not visible.

Affinities: This organism may be a variety of *N. ovalis*, or possibly a distinct species. However, only a limited amount of material for identification was available, as it was found in only one host (of 70 specimens of Blattidae).

SUMMARY

Fourteen newly described species and one new subspecies of protozoan parasites were recognized in this study, in addition to nine species which had been previously described by other investigators. Twenty-two (or twenty-four?) new hosts were named and new parasites were added for twelve (or ten?) orthopteran hosts which had been previously studied by others. (The exact number is uncertain because of certain incorrect host determinations made by other investigators.)

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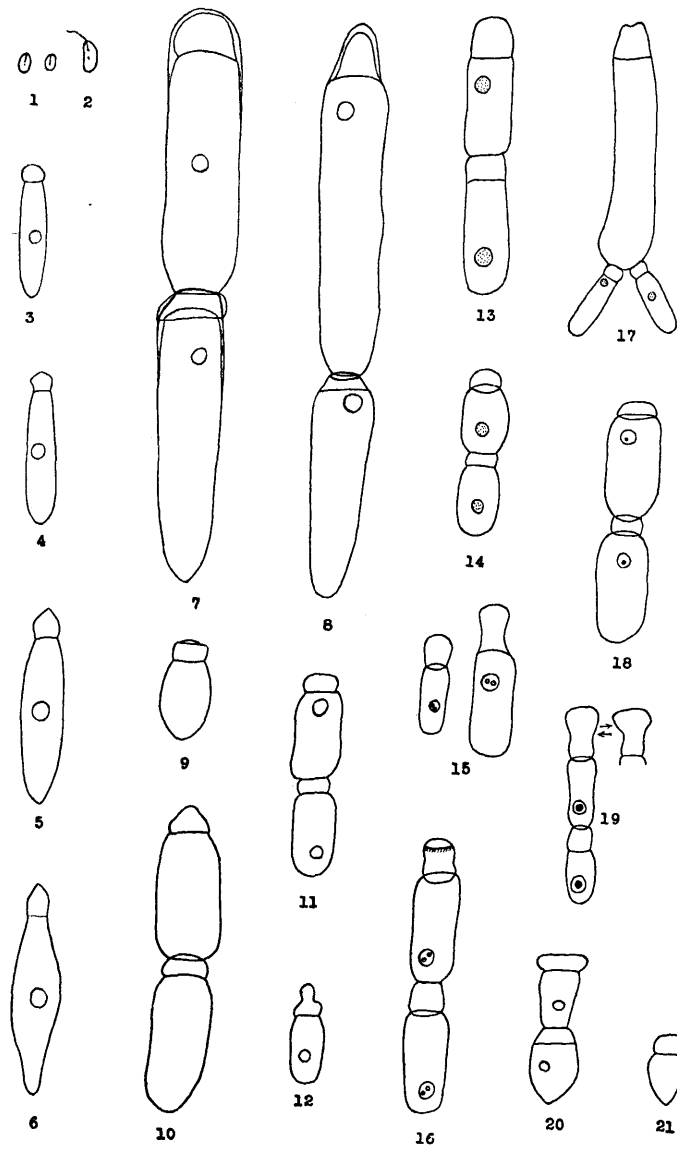
EXPLANATION OF PLATES

PLATE I

Fig. 1. *Leptomonas* sp., *Leishmania* stage?
Fig. 2. *Leptomonas* sp., *Leptomonas* stage.
Fig. 3. *Leidyana gryllorum* (Cuénot), adult sporont.
Figs. 4, 5, 6. *Leidyana erratica* (Crawley), adult sporonts.
Fig. 7. *Gregarina ohioensis* n. sp., adult association.
Fig. 8. *Gregarina thomasi* n. sp., adult association.
Fig. 9. *Gregarina parcoblattae* n. sp., immature sporont.
Figs. 10, 11. *Gregarina parcoblattae* n. sp., adult associations.
Fig. 12. *Gregarina rigida columna* n. subsp. or *G. r. rigida* (Hall) (?), cephalont.
Fig. 13. *Gregarina rigida columna* n. subsp., adult association.
Fig. 14. *Gregarina r. rigida* (Hall), adult association.
Fig. 15. *Gregarina indianensis* n. sp., immature sporonts.
Fig. 16. *Gregarina indianensis* n. sp., adult association.
Fig. 17. *Gregarina nigra* Watson (atypical as to width-length proportions), association of one adult and two immature sporonts.
Fig. 18. *Gregarina locustae* Lankester, adult association.
Fig. 19. *Gregarina kingi* Crawley, small adult association.
Fig. 20. *Gregarina galliveri* Watson, adult association.
Fig. 21. *Gregarina hadenoeci* n. sp., immature sporont.

PLATE II

Fig. 22. *Gregarina hadenoeci* n. sp., adult association.
Fig. 23. *Gregarina proteocephala* n. sp., adult association.
Fig. 24. *Gregarina proteocephala* n. sp., cephalont (of this species?).
Fig. 25. *Gregarina proteocephala* n. sp., primite of adult association, showing another occasional shape.
Fig. 26. *Gregarina* sp., adult association.
Fig. 27. *Gregarina ceuthophili* n. sp., immature sporont.
Figs. 28, 29. *Gregarina ceuthophili* n. sp., adult associations.
Fig. 30. *Gregarina ceuthophili* n. sp., cyst (of this species?), illustrating amount of shrinkage in three days. Arrows indicate shrinkage.
Fig. 31. *Gregarina prima* n. sp., adult association.
Figs. 32, 33. *Gregarina acrydiinarum* n. sp., adult associations.
Fig. 34. *Gregarina acrydiinarum* n. sp., primite protomerites, illustrating characteristic change of shape.
Fig. 35. *Gregarina acrydiinarum* n. sp., primite protomerite after fixing and staining.
Fig. 36. *Gregarina oviceps* Diesing, small association (probably immature).
Fig. 37. *Pileocephalus tachycines* n. sp., cephalont.
Fig. 38. *Pileocephalus tachycines* n. sp., epimerite of another shape.
Fig. 39. *Pileocephalus tachycines* n. sp., sporonts (of adult age approximately).
Fig. 40. *Actinocephalus* sp., adult sporont.
Fig. 41. *Actinocephalus elongatus* n. sp., cephalont.
Figs. 42, 43. *Actinocephalus elongatus* n. sp., adult sporonts (adhering to debris in Fig. 43).
Fig. 44. *Nyctotherus ovalis* Leidy (probably a variety).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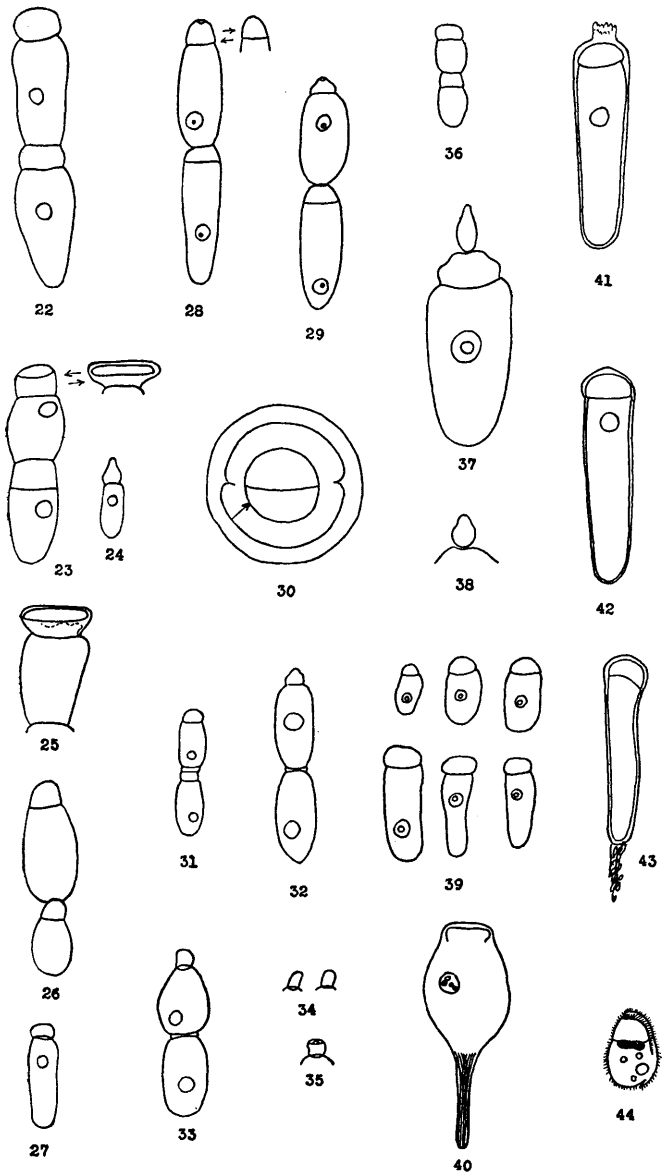
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